CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. A computer implemented encoding and correcting method comprising the step of performing only exclusive OR operations on words for error correcting codes with four or more check symbols which can correct as many errors are there are check symbols.

2. A computer implemented method for encoding data and correcting erasure errors comprising the steps of:

converting a code over a finite field of characteristic two which can correct up to e erasure errors into a code which can correct up to e erasure errors in words;

encoding data using the converted code;

reading the encoded data and correcting up to e erasure errors in words.

3. The computer implemented method for encoding data and correcting erasure errors recited in claim 2, wherein the converted code is a (3, 3) code, wherein even if all the information in any three of the words w_i is erased, the data can be recovered.

4. A computer implemented encoding and correcting method comprising the steps of:

transforming encoding and decoding matrices of $GF(2^n)$, the Galois

Field of 2^n elements for n greater than one, and

encoding data and correcting erasure errors using only exclusive OR operations on words.

5. The computer implemented encoding and correcting method recited in claim 4, wherein a (3, 3) code of distance four is used.

6. A computer implemented method for encoding and correcting four or more erasure errors in data whose locations are known, comprising the steps of:

converting a code over a finite field of characteristic two into a code whose encoding and correcting algorithms involve only exclusive OR (XOR) operations of words;

reading data from main volatile memory and encoding the data using only XOR operations to generate a correcting code;

storing data and correcting code in an auxiliary array of non-volatile storage devices;

reading the data from the auxiliary array of non-volatile storage devices; and

reconstructing erasure errors in the data read from the auxiliary array of non-volatile storage devices using only XOR operations to generate reconstructed data.

7. The computer implemented method recited in claim 6, wherein the code whose encoding and correcting algorithms involve only XOR operations of words is a (3, 3) code of distance four.

8. The computer implemented method recited in claim 7, wherein the code whose encoding and correcting algorithms involve only XOR operations of

words is based on a code of six symbols, x_0, x_1, x_2, x_3, x_4, and x_5, each of which is an element of GF(4), the Galois Field of four elements, and where x_0, x_1 and x_2 are information symbols and x_3, x_4 and x_5 are check symbols, the check symbols being defined by:

$$\begin{bmatrix} x_3 \\ x_4 \\ x_5 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix} \begin{bmatrix} x_0 \\ x_1 \\ x_2 \end{bmatrix}, \text{ that is } \underline{X}_C = A\underline{X}_1,$$

where a is an element of GF(4) which satisfies the equation $1+a+a^2=0$.

9. The computer implemented method recited in claim 8, wherein by substitution $\underline{X}_C = A\underline{X}_1$ becomes $\underline{W}_C = r(A)\underline{W}_1$, where $\underline{W}_C$ is a correction word and $\underline{W}_1$ is a data word to be reconstructed.

10. The computer implemented method recited in claim 9, wherein, given a linear code over GF(2^n), the Galois Field of 2^n elements, which can correct up to e erasure errors, to a code which can correct up to e erasures in words, and whose encoding and correcting can be performed by XORing words, the method comprises the steps of:

encoding the linear code in the form $\underline{X}_C = A\underline{X}_1$, and each of the corrections is also of the form $x_i = B_i\underline{X}$, where A and the B_is are matrices over GF(2^n);

choosing a representation, r, of GF(2^n), which representation assigns an $n \times n$ matrix, $r(a)$, for every element a in GF(2^n), whose elements are in

GF(2), i.e., are "0" or "1";

obtaining the decoder of converted code by substituting the matrix $r(a)$ for every element a of A, to obtain the matrix A, and substituting w_i for x_i in $\underline{X}_1$ and in $\underline{X}_C$, where $w_i = (w_{i,0}, w_{i,1}, \ldots, w_{i,n-1})'$ to obtain $\underline{W}_1$ and $\underline{W}_C$, the encoder of the code being $\underline{W}_C = r(A)\underline{W}_1$; and

substituting $r(a)$ for every element a of B_i to obtain $r(B_i)$ and substituting w_j for every element x_j of $\underline{X}$ to obtain $\underline{W}$ to recover x_i by using $w_i = r(B_i)\underline{W}$.

11. A computer system for correcting four or more erasure errors whose locations are known, comprising:

a main volatile memory and an auxiliary array of non-volatile storage devices connected for transferring data therebetween;

an encoding means for converting a code over a finite field of characteristic two into a code whose encoding and correcting algorithms involve only exclusive OR (XOR) operations of words, data read from said main volatile memory being encoded by said encoding means using only XOR operations to generate a correcting code and stored with the correcting code in said auxiliary array of non-volatile storage devices; and

data reconstructing means which, when data is read from the auxiliary array of non-volatile storage devices, reconstructs erasure errors in the data read from the auxiliary array of non-volatile storage devices using only XOR operations to generate reconstructed data.

12. The computer system recited in claim 11, wherein the code whose encoding and correcting algorithms involve only XOR operations of words is a (3, 3) code of distance four.